US006677840B2

(12) **United States Patent**
Nakamura et al.

(10) **Patent No.: US 6,677,840 B2**
(45) **Date of Patent: Jan. 13, 2004**

(54) **ELECTROMAGNETIC RELAY**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/903,614**

(22) Filed: **Jul. 13, 2001**

(65) **Prior Publication Data**

US 2002/0036557 A1 Mar. 28, 2002

(30) **Foreign Application Priority Data**

Jul. 18, 2000 (JP) 2000-222401
Dec. 8, 2000 (JP) 2000-374314

(51) **Int. Cl.**[7] **H01H 67/02**
(52) **U.S. Cl.** **335/128**; 335/83
(58) **Field of Search** 335/78–86, 124, 335/128, 202

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(57) **ABSTRACT**

An electromagnetic relay of a simple structure for reliably making and breaking a high load voltage. First and second fixed contact terminals are mounted on an insulating base block. First and second branched moving pieces are attached to the lower side of a hanging portion of a spring member. When a relay coil is not excited, the first and second moving pieces are resiliently urged into contact with a back-stop plate, displaced from the first and second fixed contact elements. When the relay coil is excited, contact elements attached to the first and second moving pieces are resiliently urged into contact with respective contact elements attached to the first and second fixed contact elements, electrically connecting the respective first and second fixed contact terminals.

45 Claims, 14 Drawing Sheets

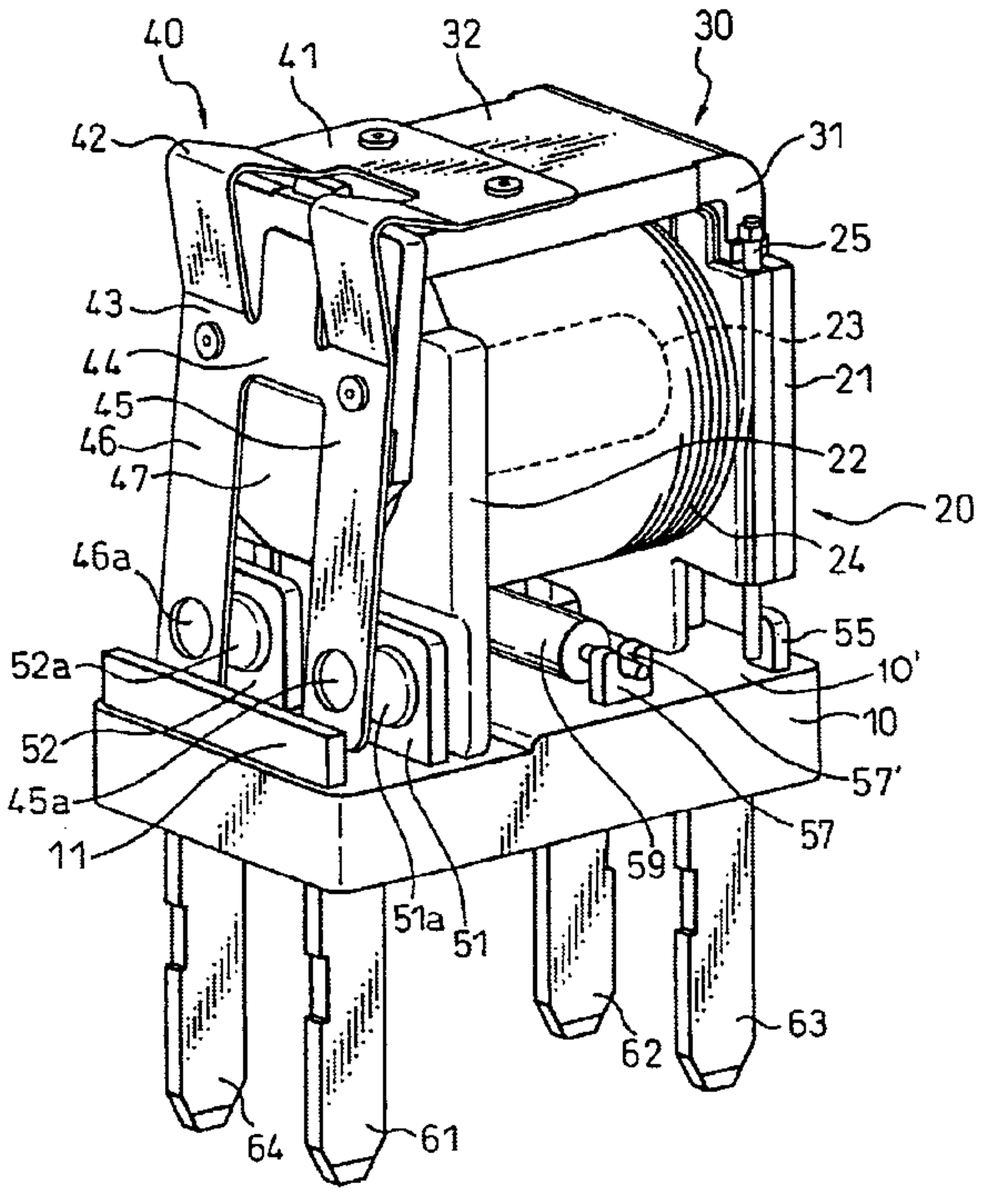
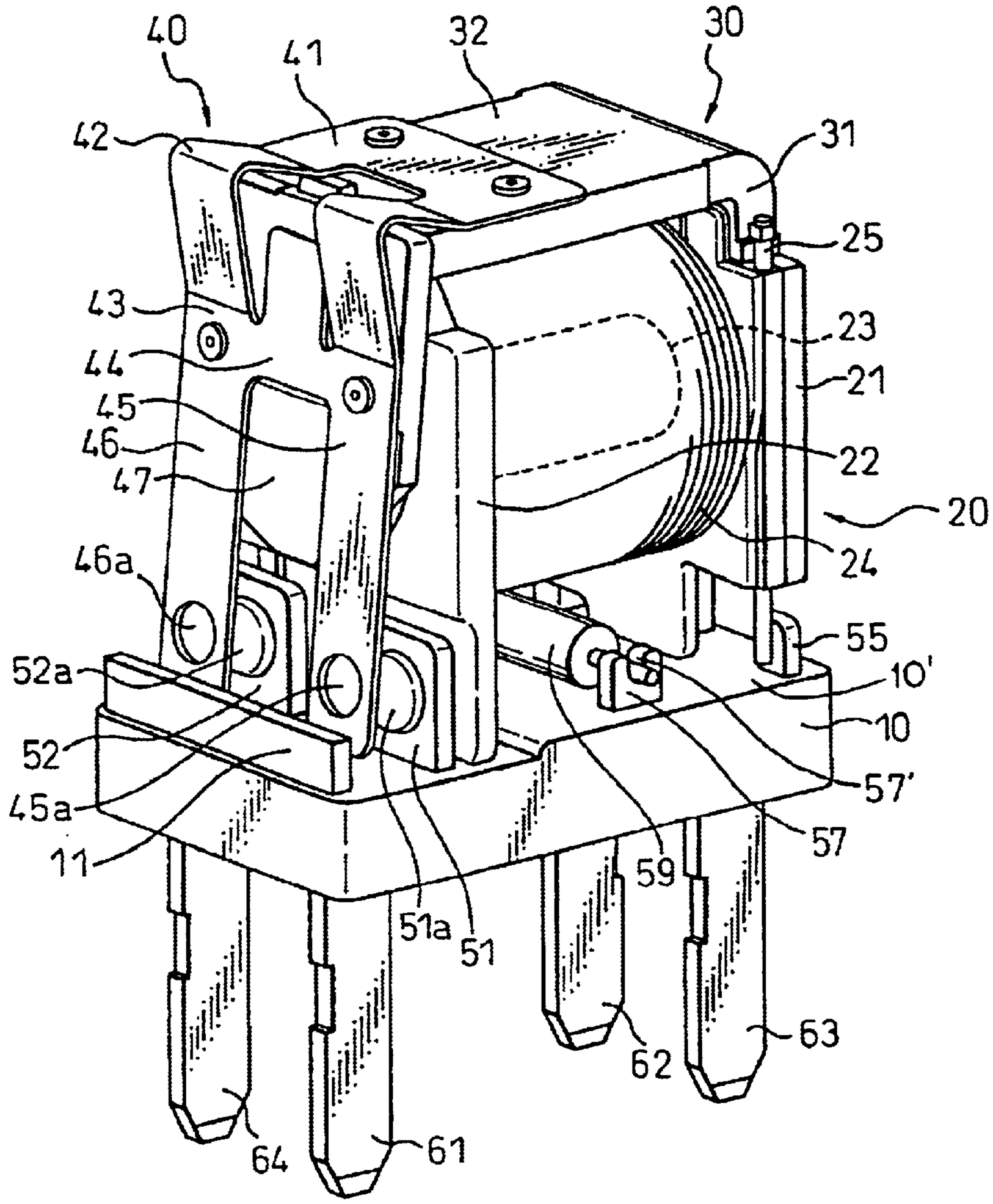


Fig.1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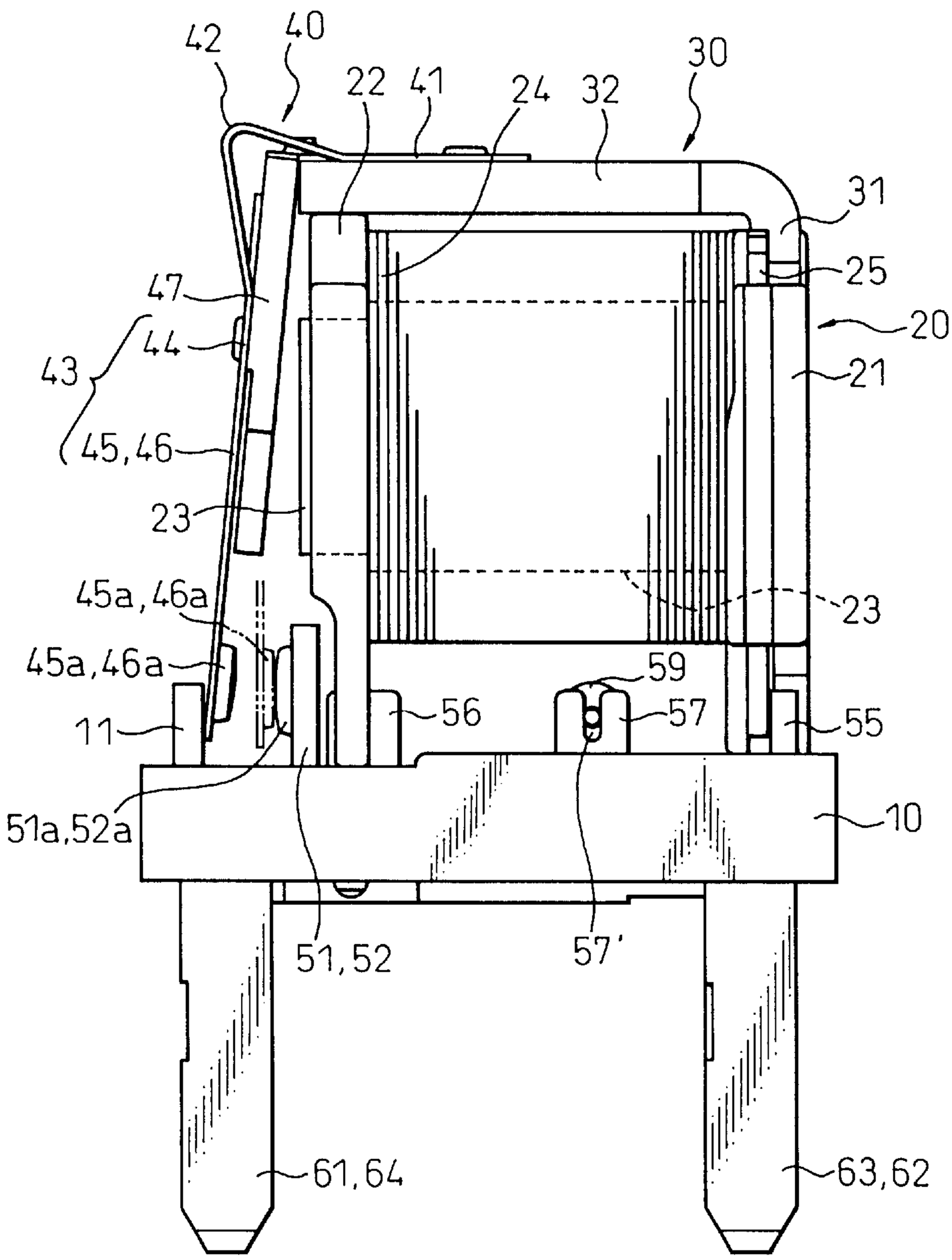
41
32
30
42
31
25
43
23
44
21
45
46
22
47
20
24
46a
55
52a
10'
52
10
57'
45a
11
57
59
51a
51
62
63
64
61

Fig. 2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47
44
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59
11
56
57
55
51a,52a
10
51,52
57'
61,64
63,62

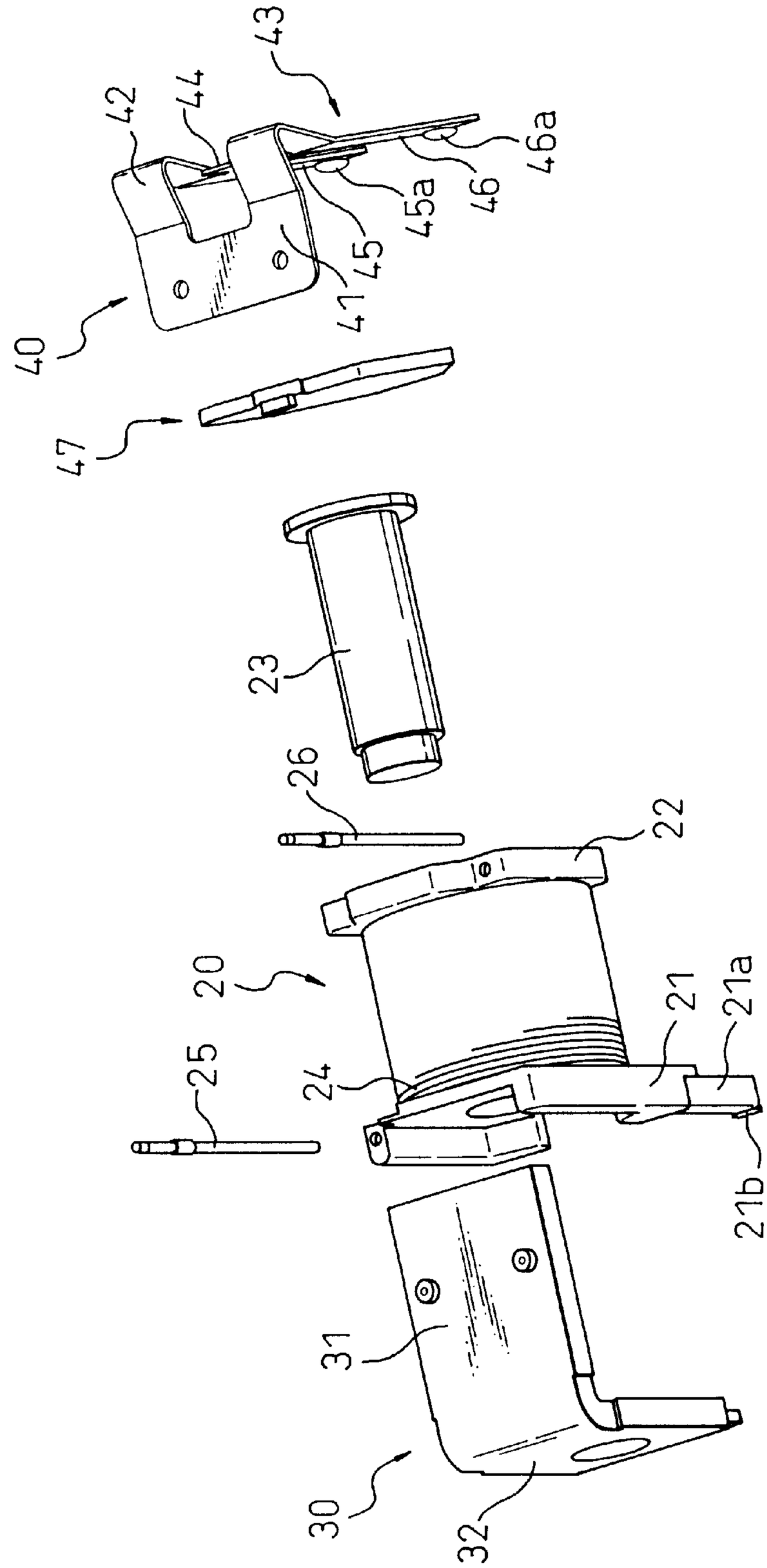


Fig. 3

Fig.4

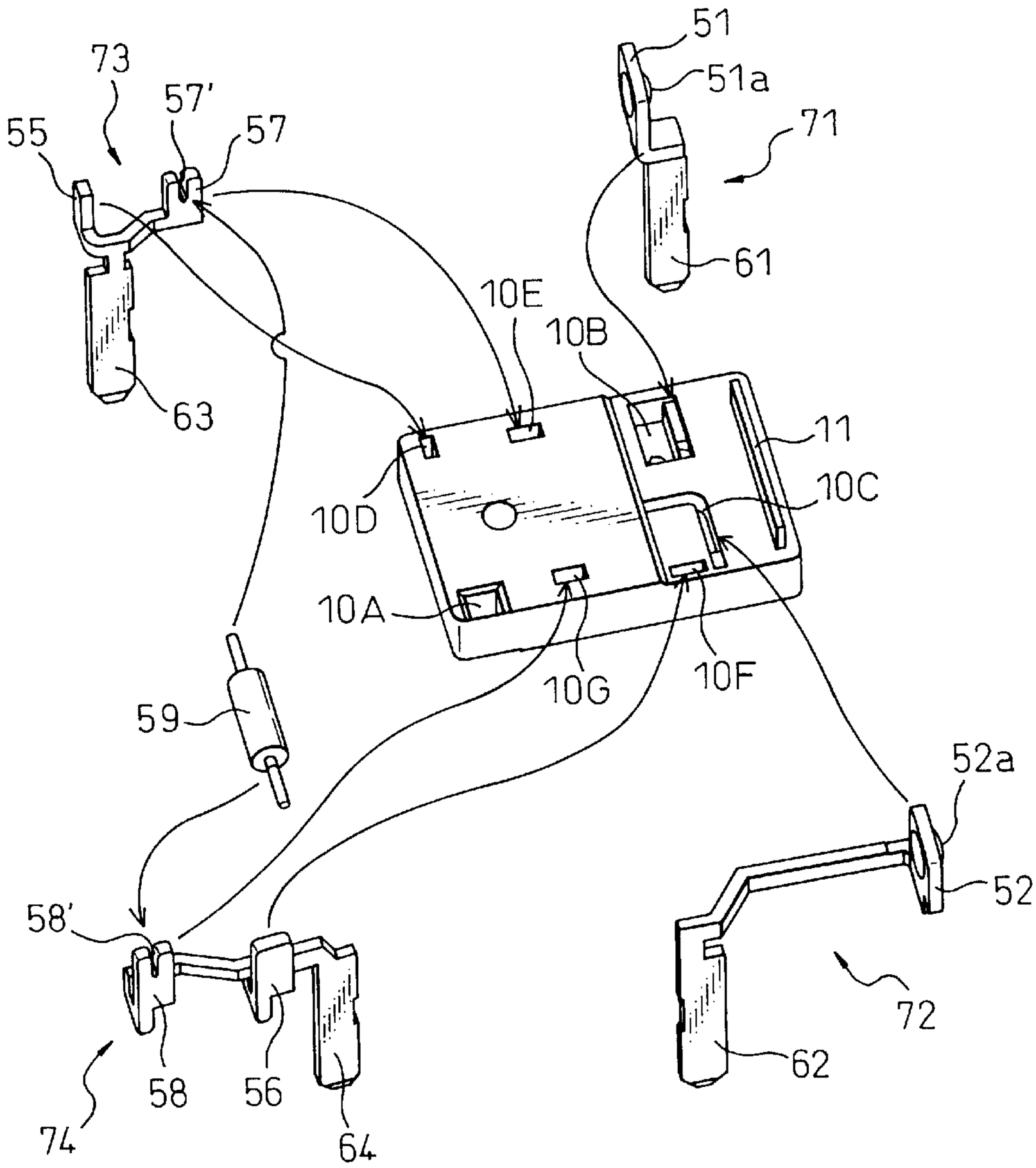

73
57'
57
55
51
51a
71
61
10E
10B
63
11
10C
10D
10A
10G
10F
59
52a
52
58'
72
58
56
62
74
64

Fig.5

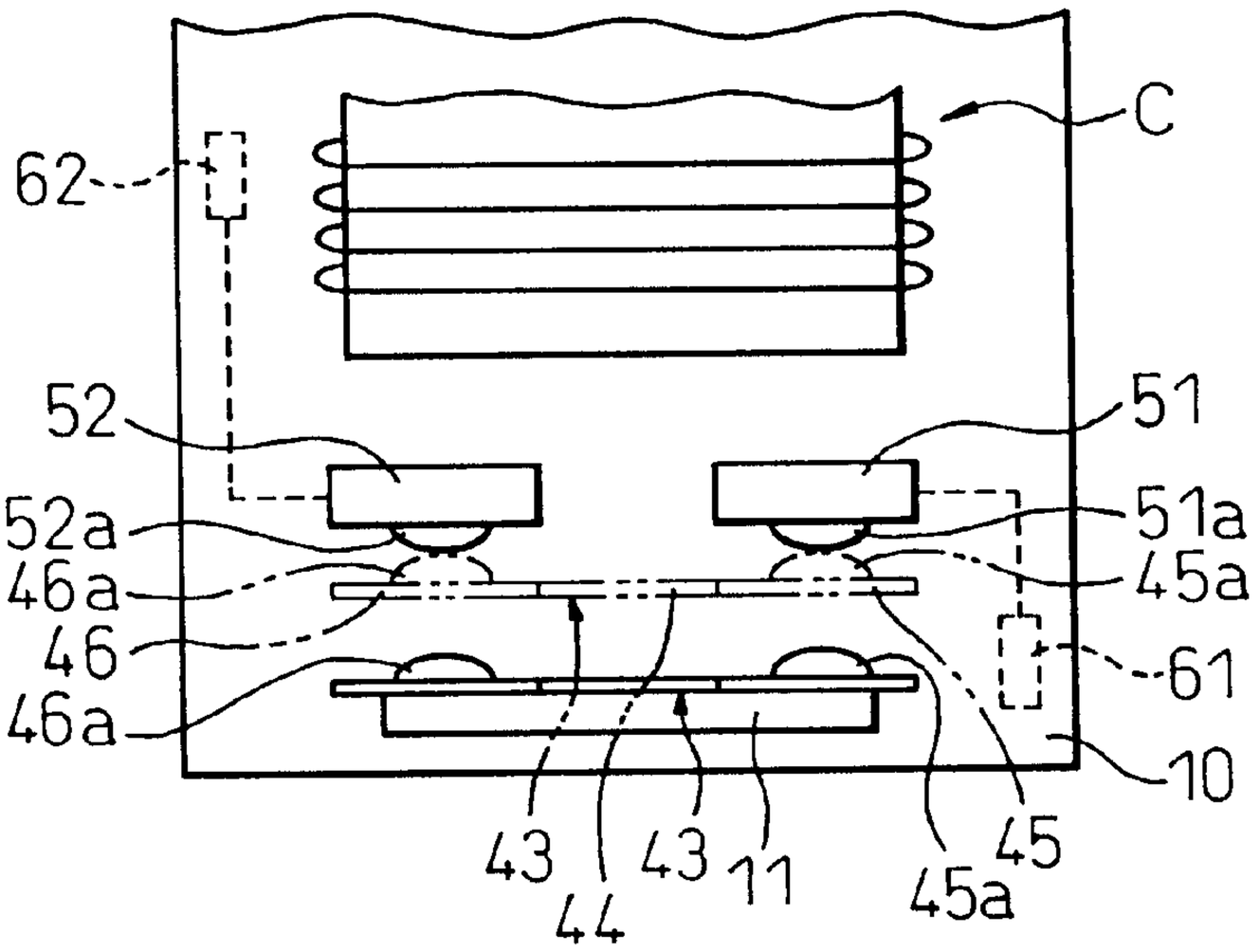

C
62
52
51
52a
51a
46a
45a
46
61
46a
10
43
43
44
11
45a
45

Fig.6

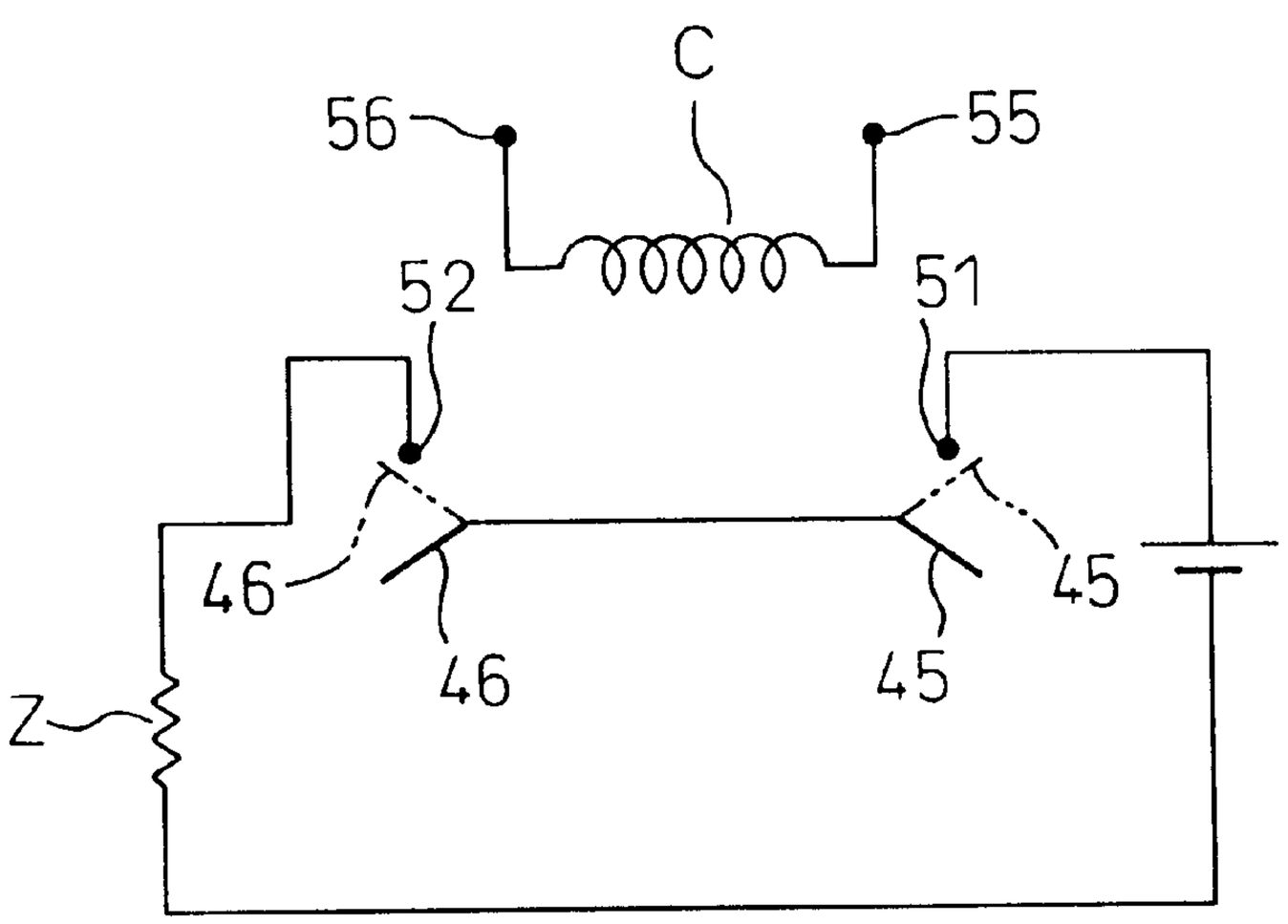
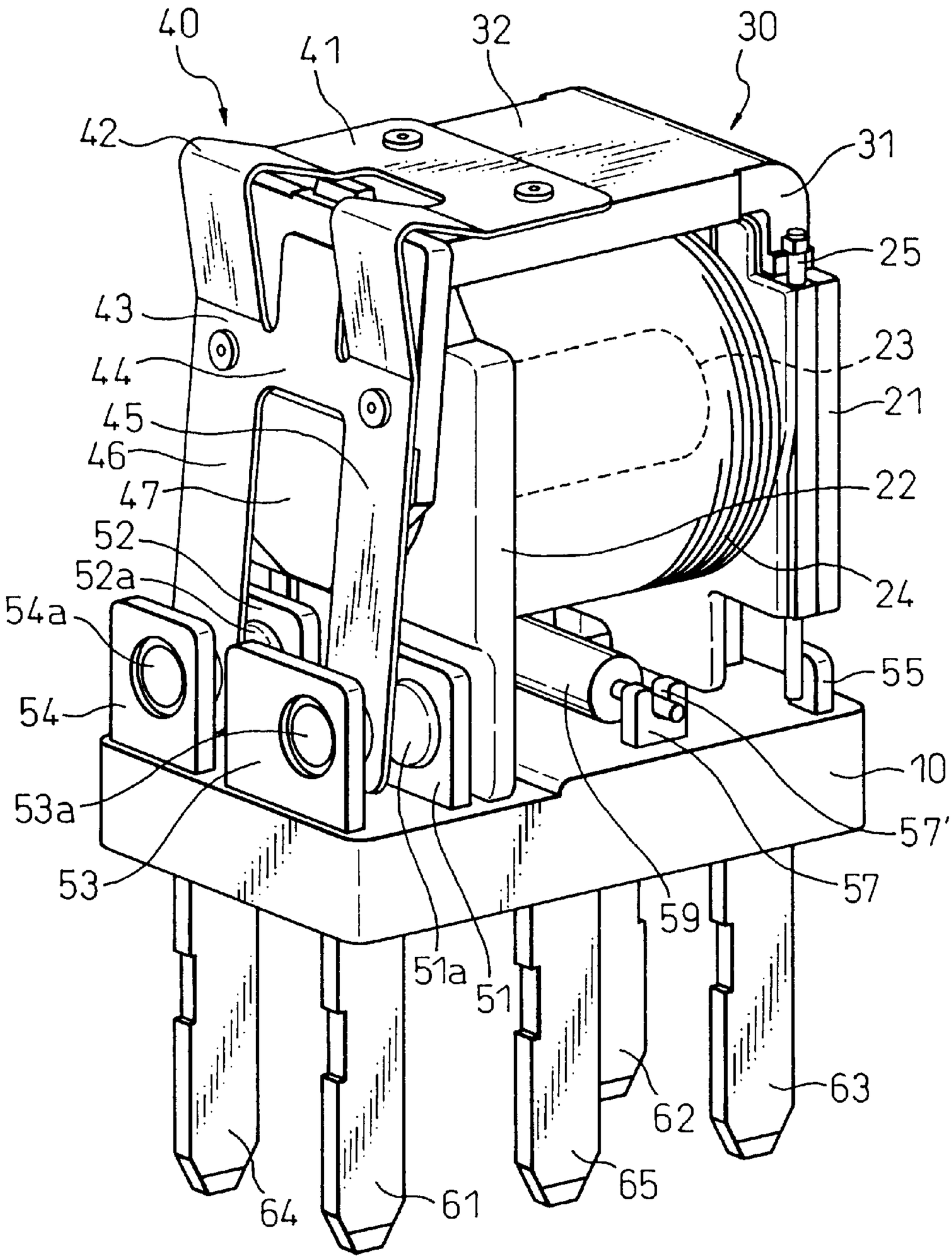

C
56
55
52
51
46
46
45
45
Z

Fig.7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45
46
22
47
52
52a
24
54a
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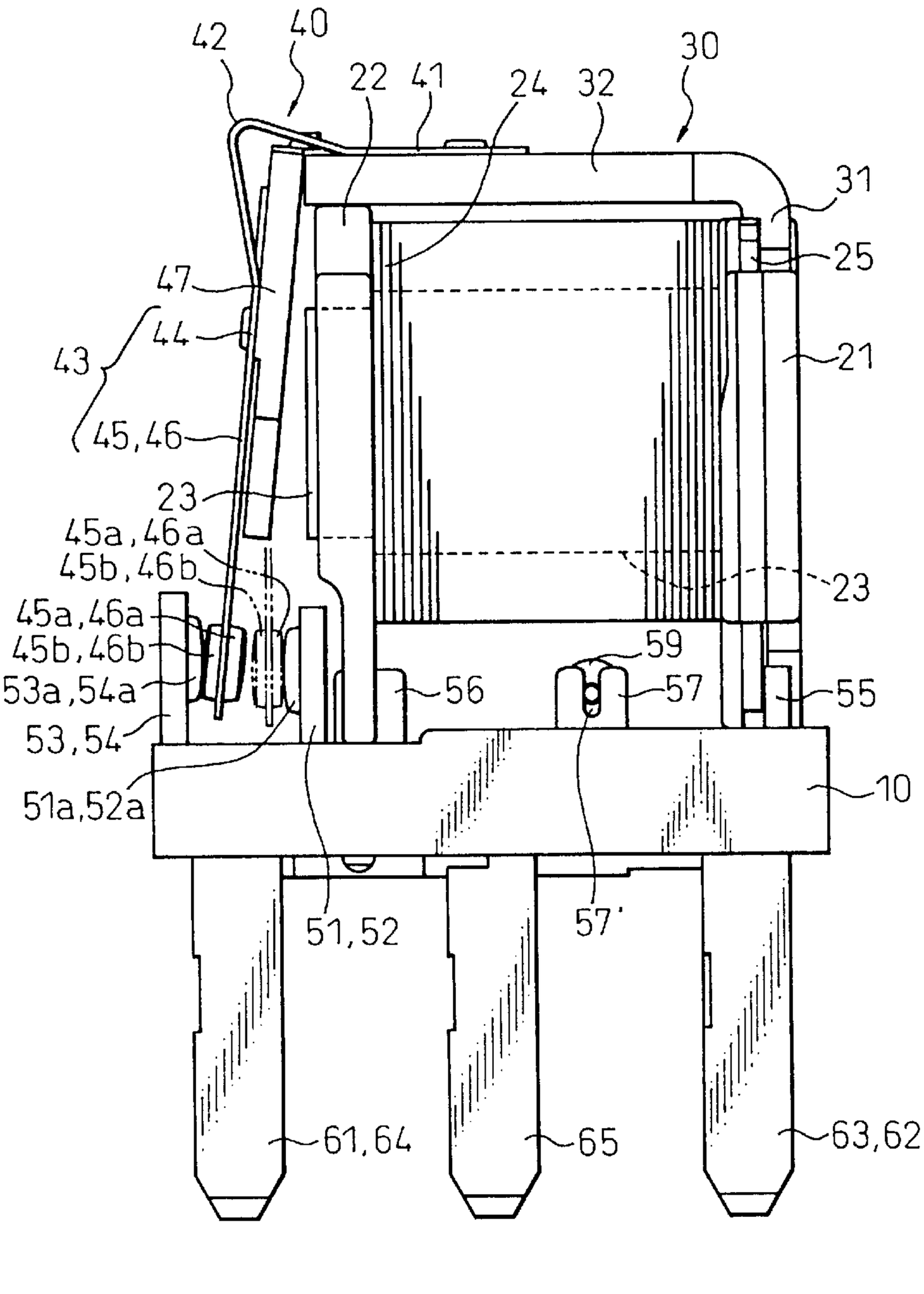
10
53a
57'
53
57
59
51a
51
62
63
64
61
65

Fig.8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43
21
45,46
23
45a,46a
45b,46b
45a,46a
45b,46b
53a,54a
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51a,52a
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56
57
55
10
51,52
57'
61,64
65
63,62

Fig.9

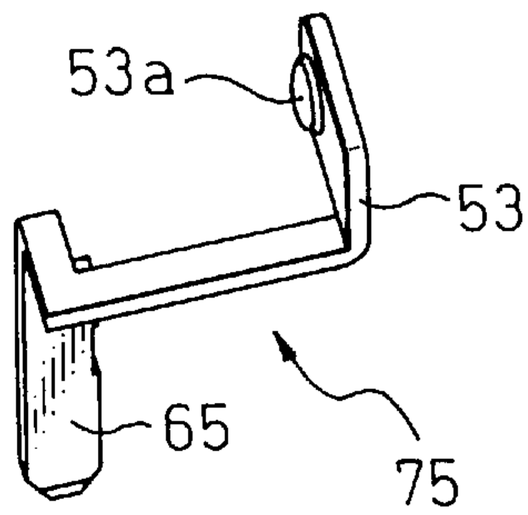


Fig.10

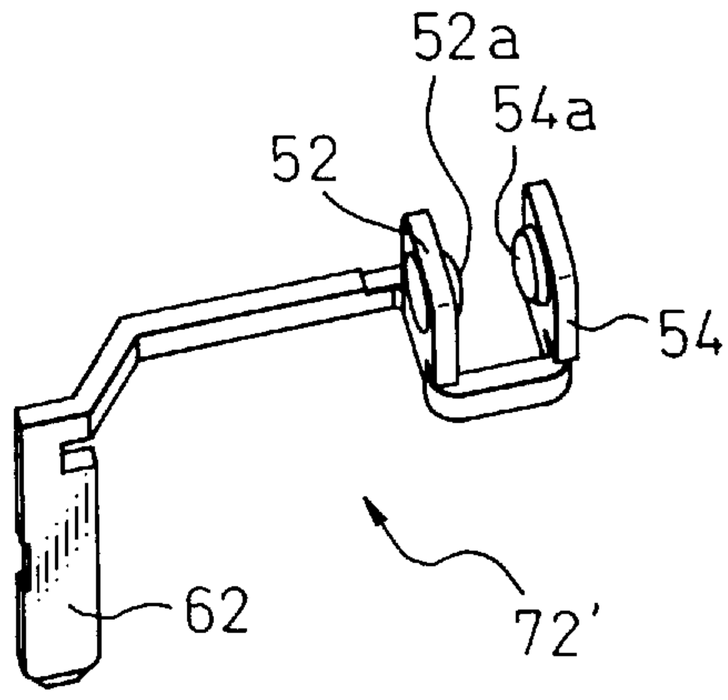


Fig.11

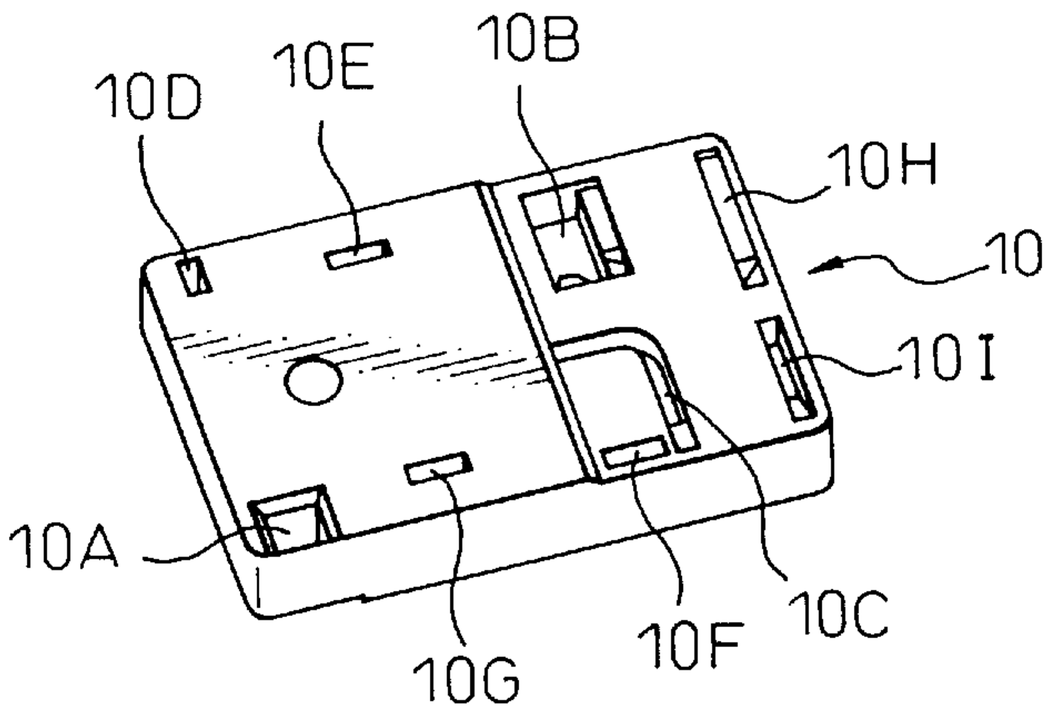


Fig.12

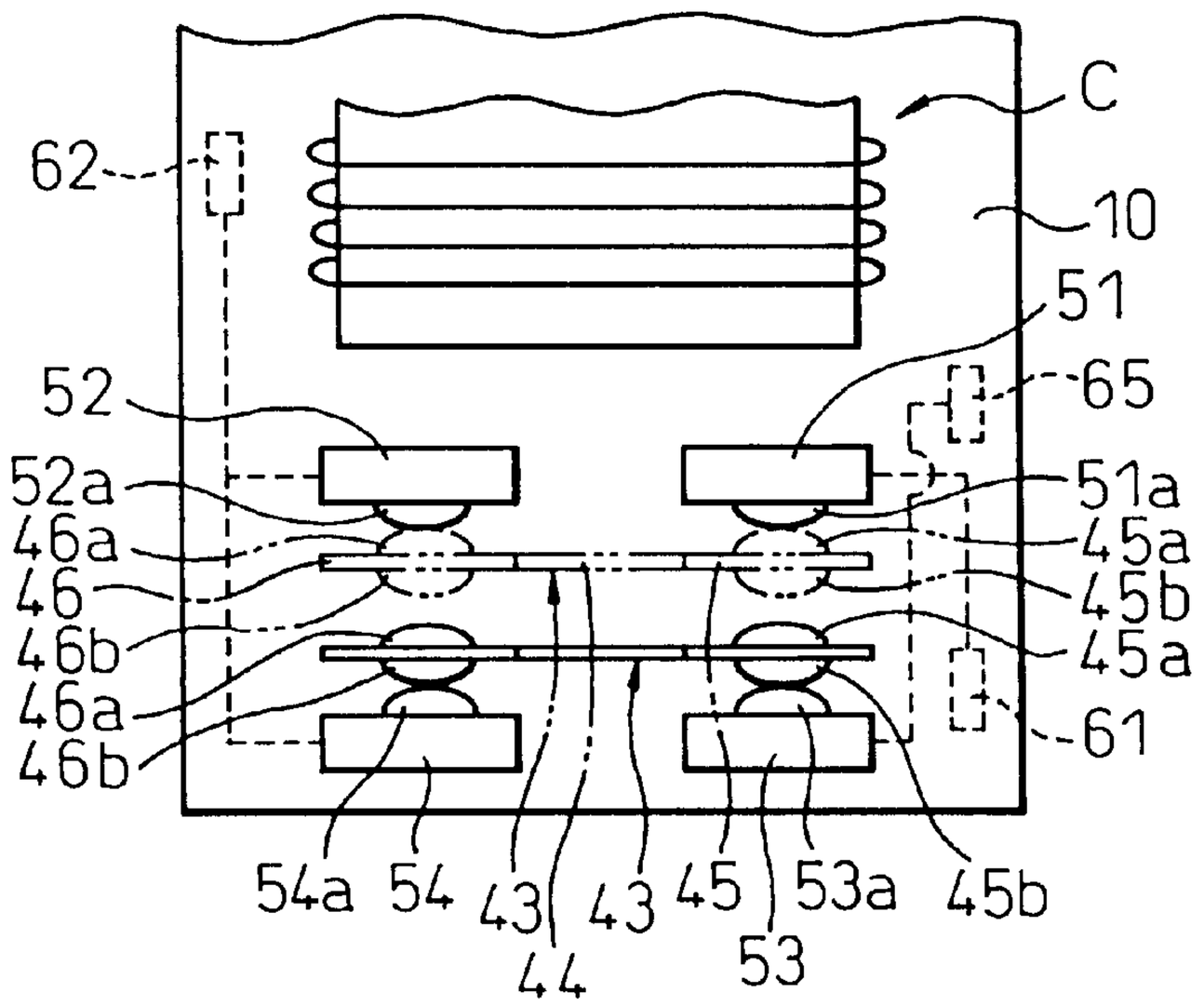

C
62
10
51
52
65
52a
51a
46a
45a
46
45b
46b
45a
46a
61
46b
54a
54
43
43
45
53a
45b
44
53

Fig.13

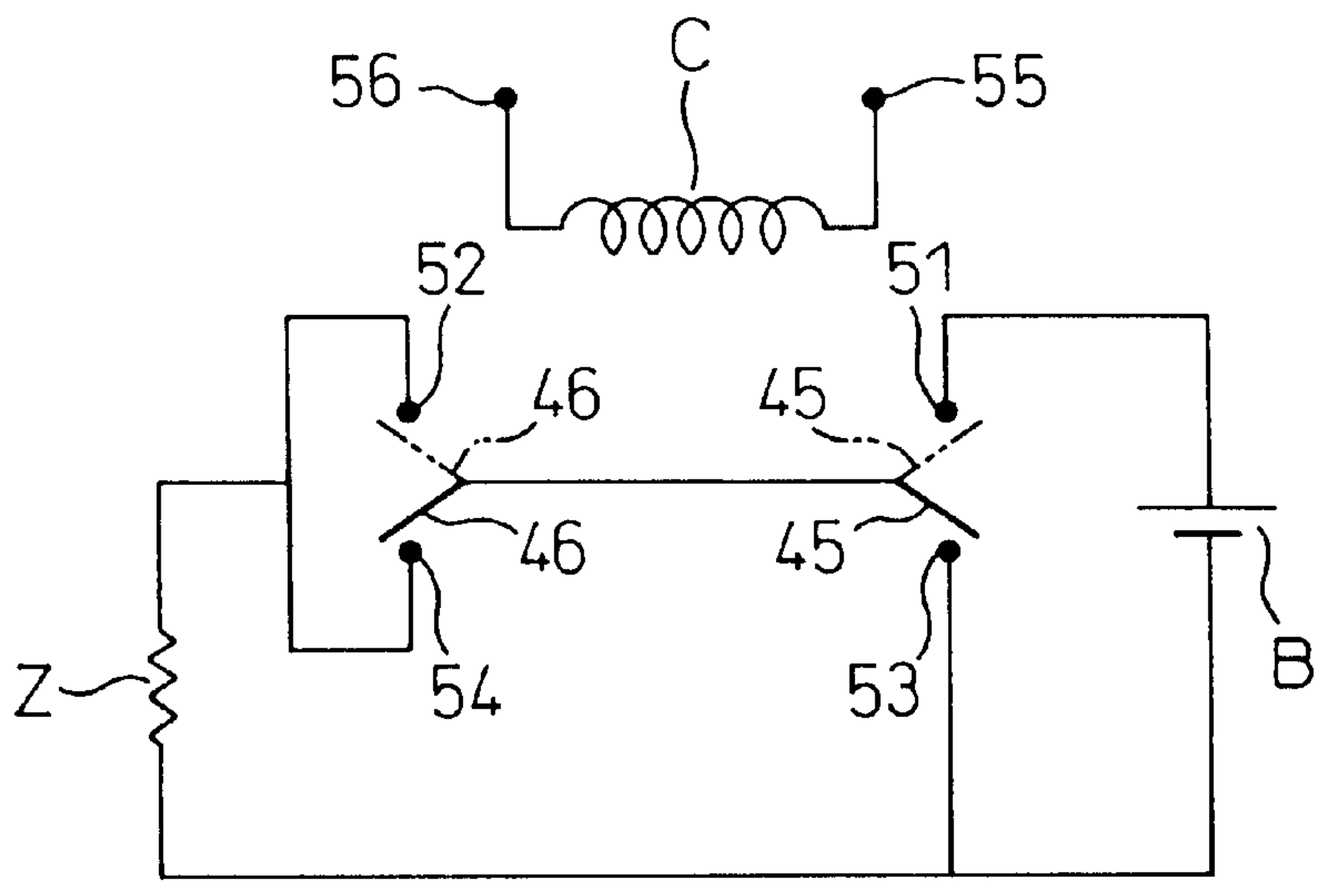
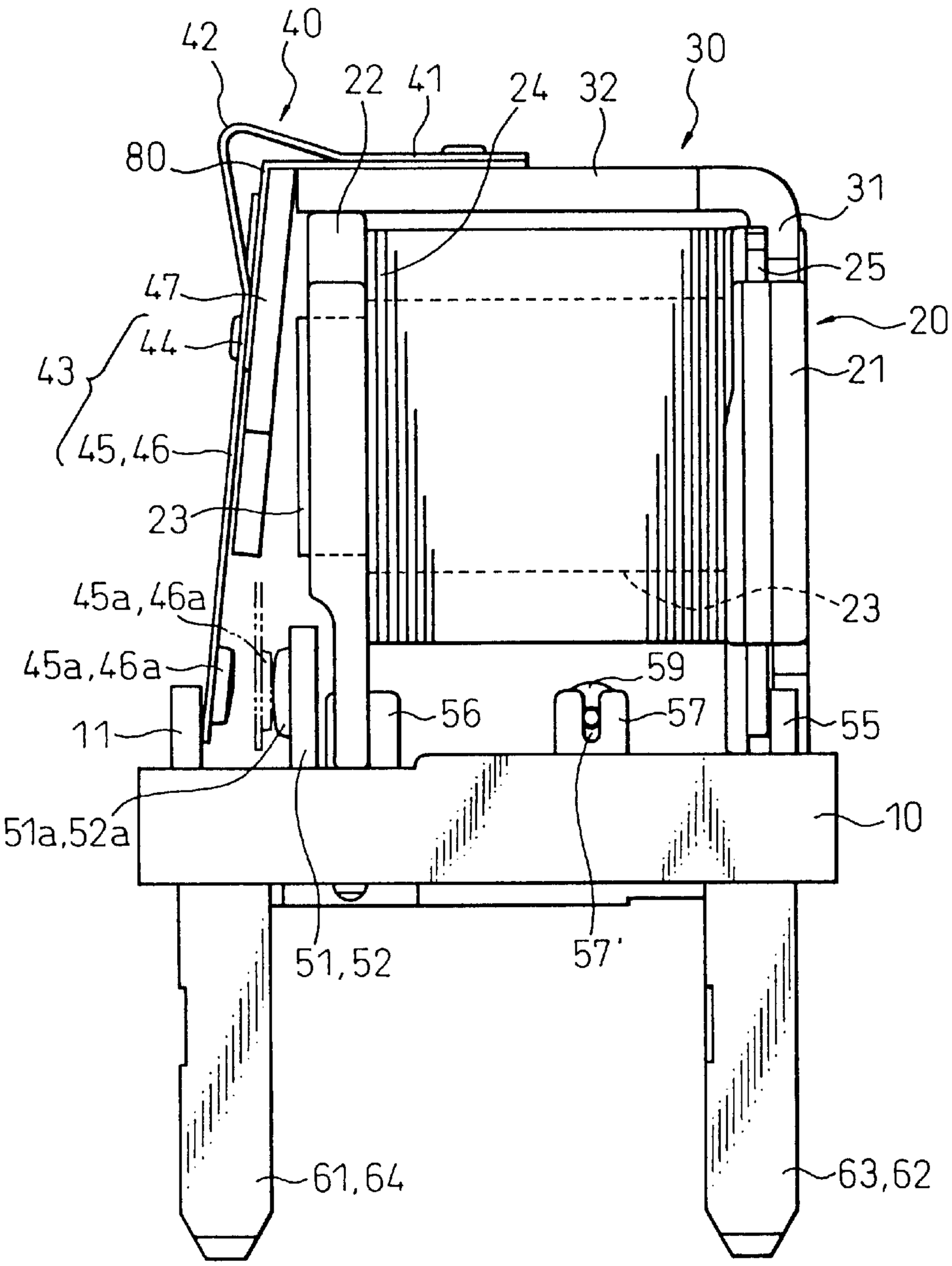

56
C
55
52
51
46
45
46
45
Z
54
53
B

Fig.14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43
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45,46
23
45a,46a
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45a,46a
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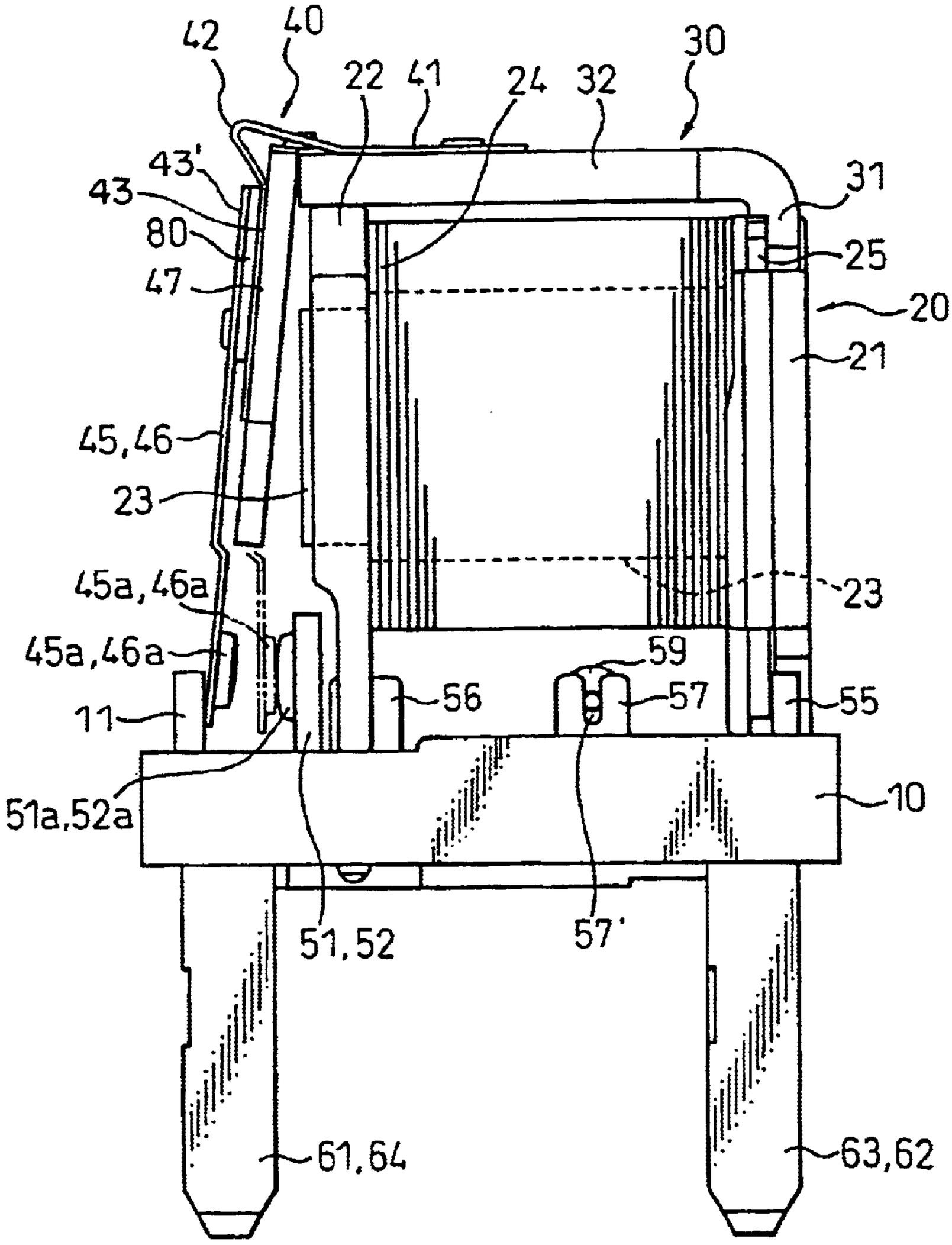
56
57
55
11
51a,52a
10
51,52
57'
61,64
63,62

Fig.15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30
43'
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80
47
31
25
20
21
45,46
23
45a,46a
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11
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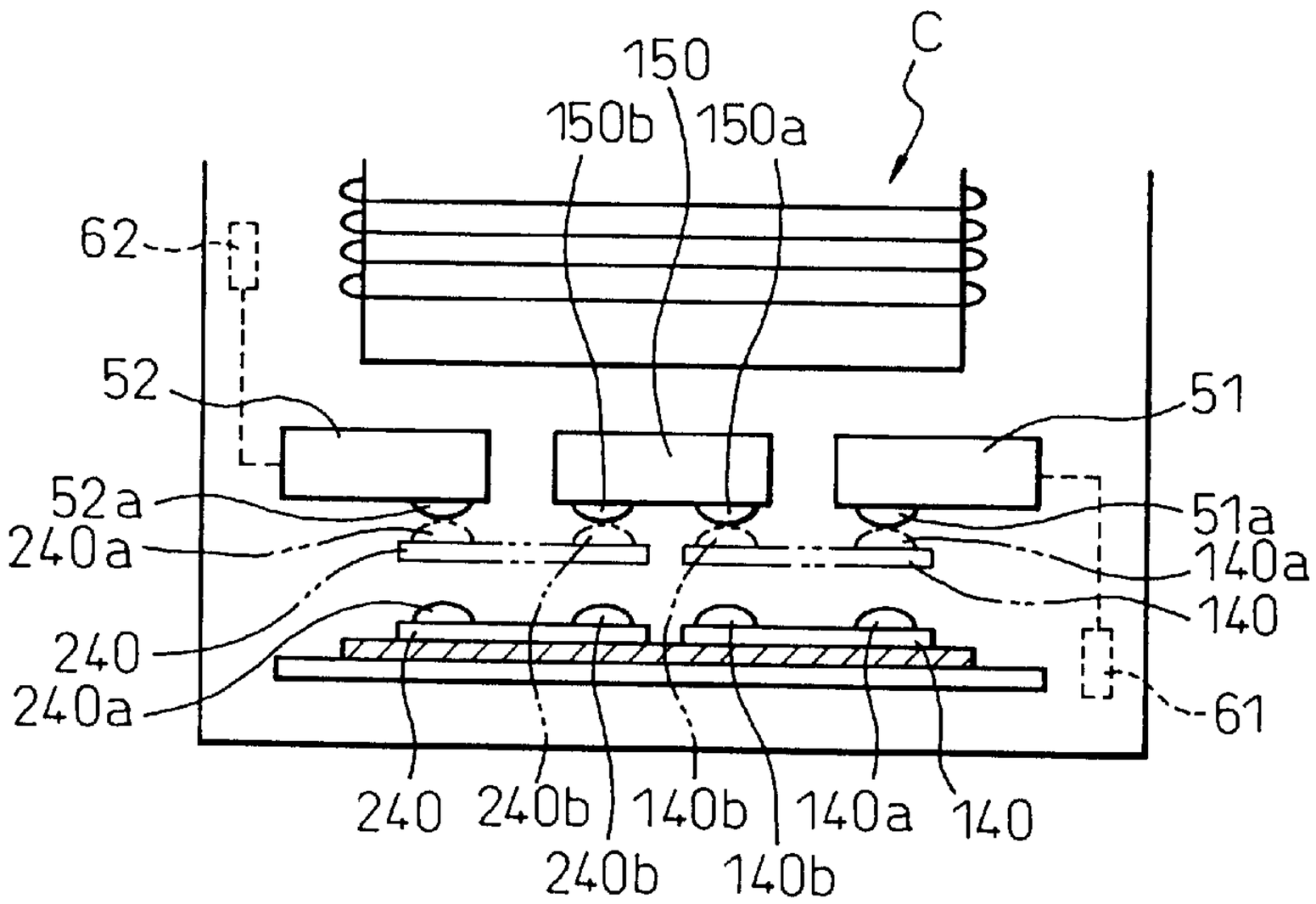
57
55
51a,52a
10
51,52
57'
61,64
63,62

Fig.16


C
150
150b
150a
62
52
51
52a
51a
240a
140a
140
240
240a
61
240
240b
140b
140a
140
240b
140b

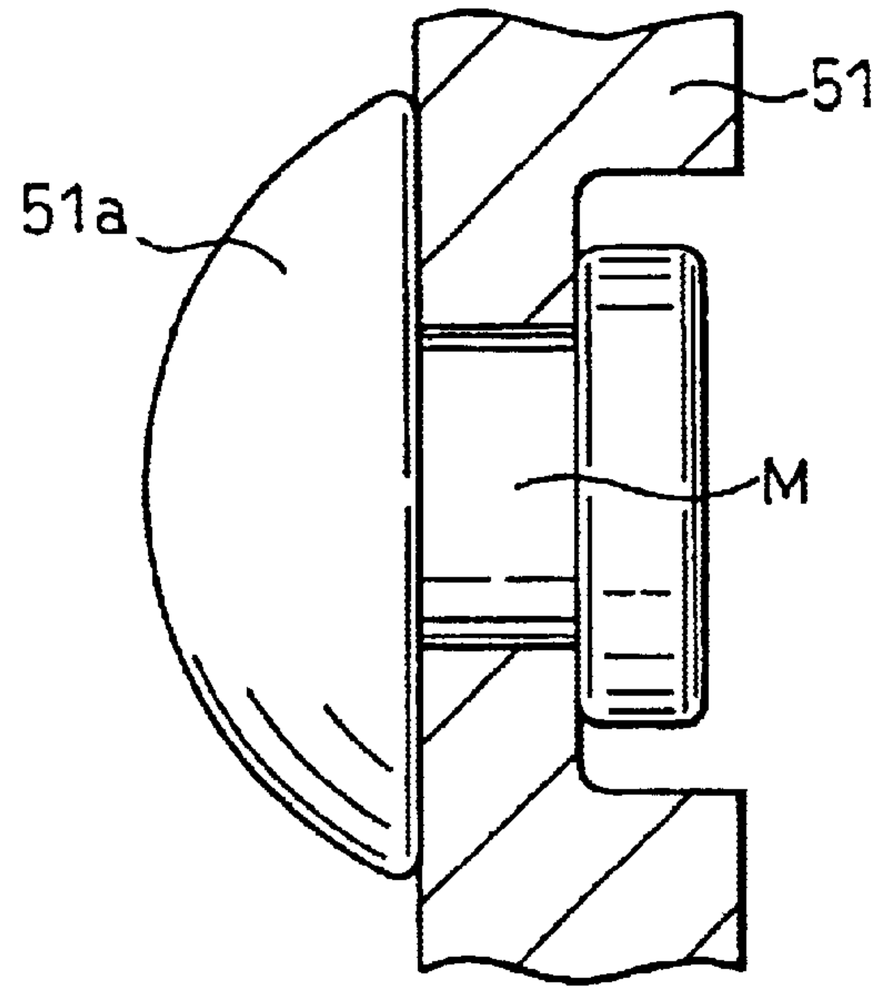


Fig.17a

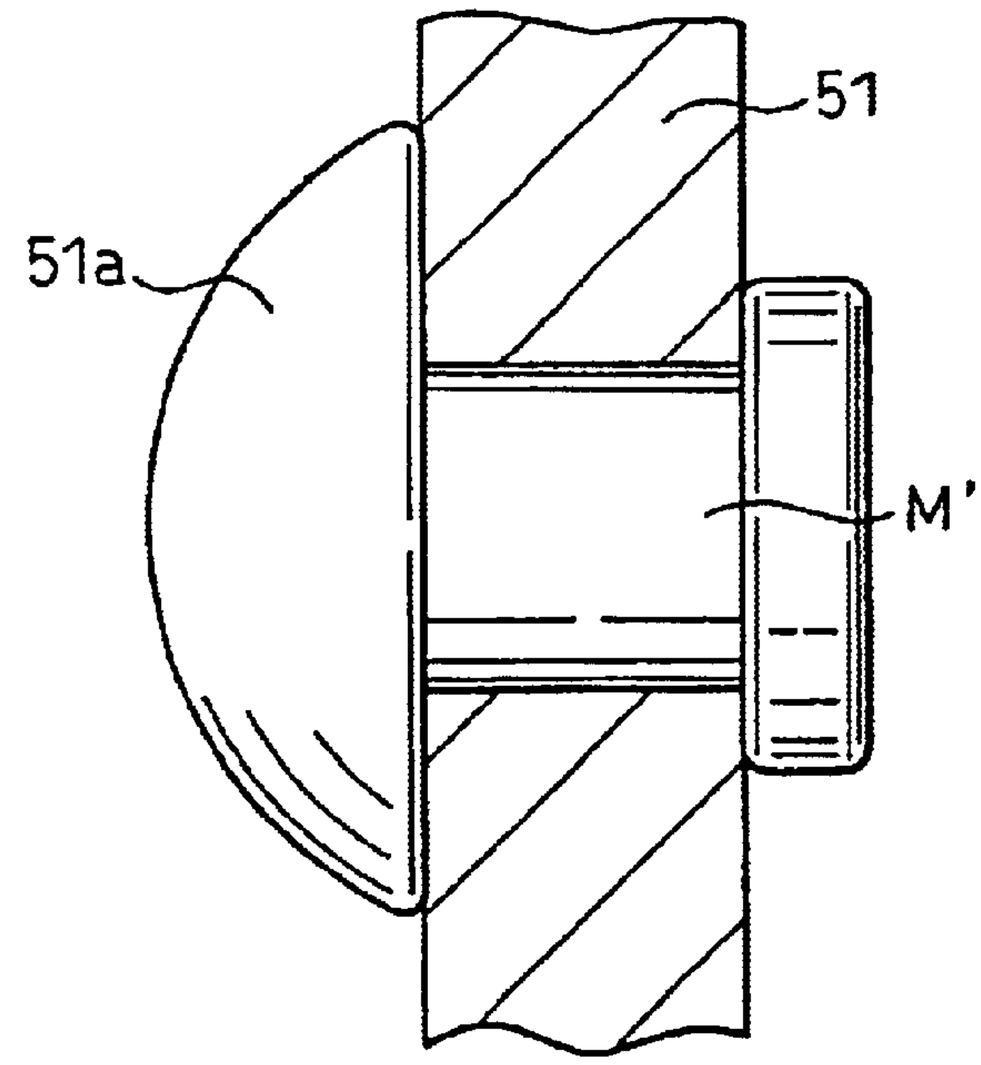


Fig.17b
PRIOR ART

Fig.18
PRIOR ART

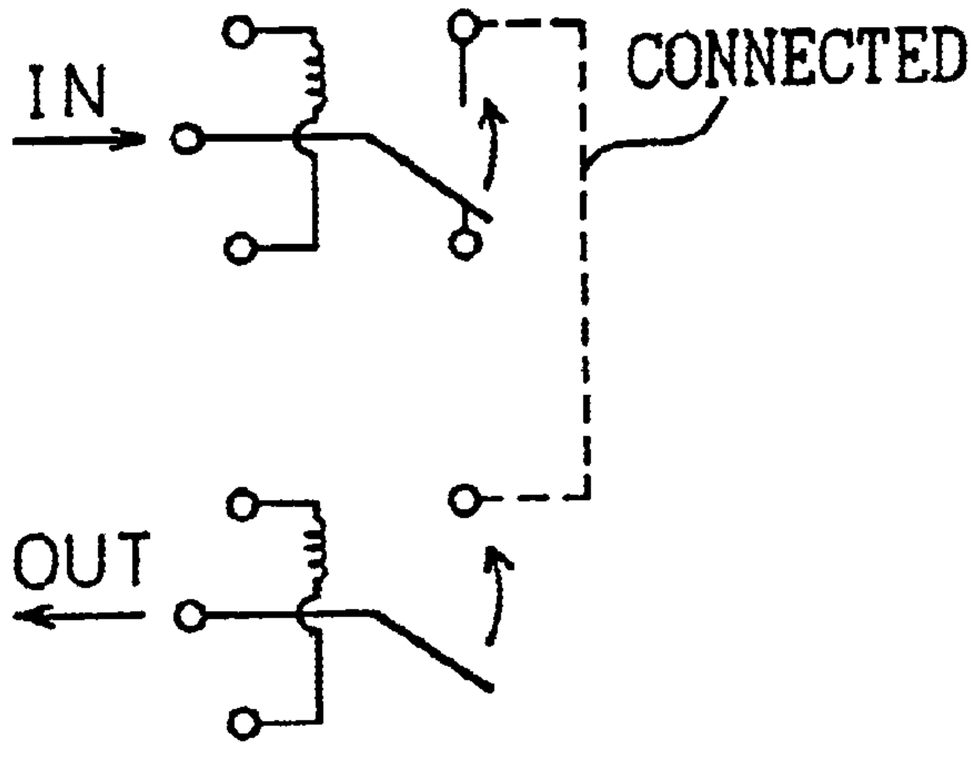
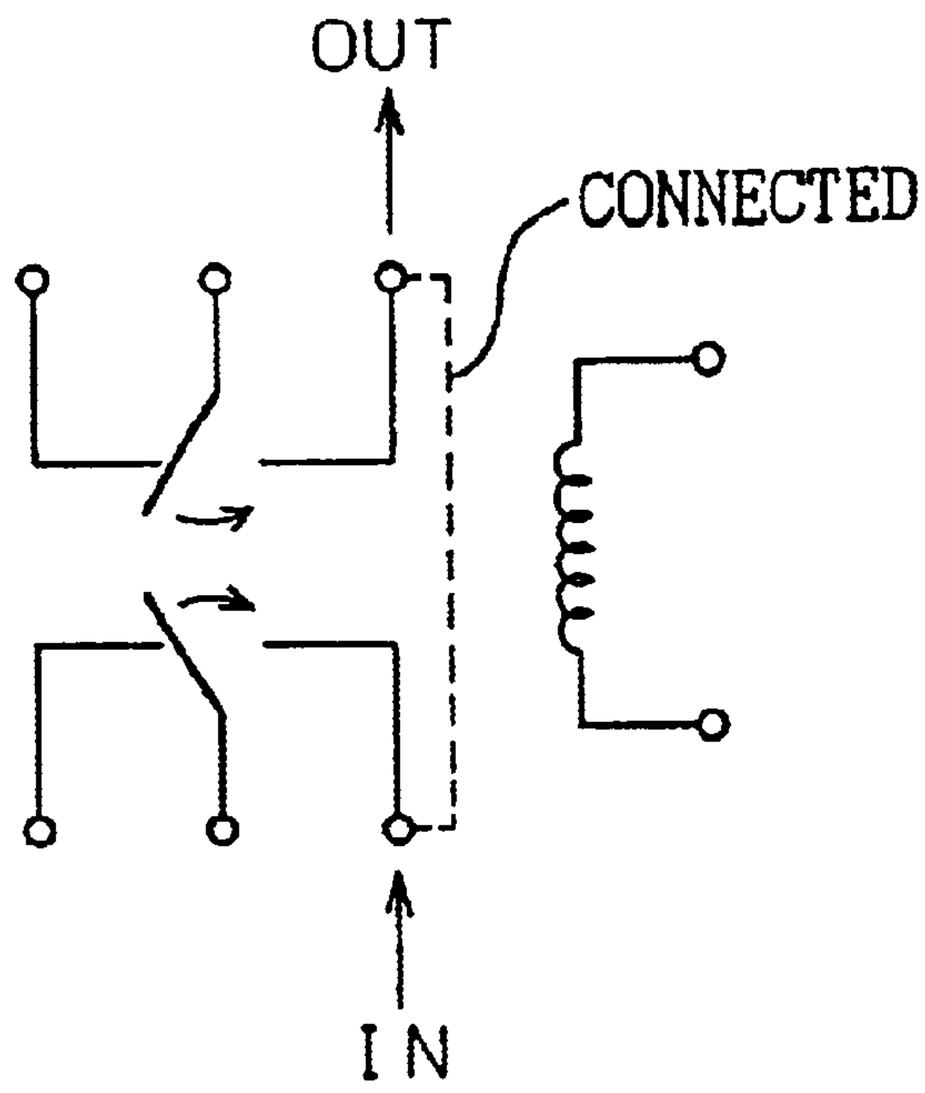


Fig.19
PRIOR ART



ELECTROMAGNETIC RELAY

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electromagnetic relay.

2. Description of the Related Art

An electromagnetic relay is used for making and breaking a load voltage. In order to reliably make and break high load voltages, however, attempts have been made to open and close the contact point by using a motor as disclosed in Japanese Unexamined Patent Publication (Kokai) No. 65685/1995. However, the device of the above publication has a complex structure and is expensive. It has therefore been attempted to connect plural electromagnetic relays each having a pair of contact terminals in series (see FIG. **18**) or to connect the contact terminals in series inside an electromagnetic relay that has plural contact terminals (see FIG. **19**).

Even in the above-mentioned case, however, defects are involved such as an increased number of steps for forming wiring to make a connection among plural connection terminals, an increase in the length of current-flow path in the relay which generates greater heat, and use of plural electromagnetic relays or of an electromagnetic relay having plural contact terminals which drives up the cost and makes it difficult to decrease the size.

SUMMARY OF THE INVENTION

In view of the above-mentioned problems, it is an object of the present invention to provide a relay of a simple structure capable of reliably making and breaking high load voltages.

According to the present invention, there is provided an electromagnetic relay which comprises

a first fixed contact terminal and a second fixed contact terminal spaced from each other on one surface of a base block,

fixed conductor pieces, in a number n−1, mounted on said one surface of said base block in alignment with and between the first fixed contact terminal and the second fixed contact terminal, and

moving conductor pieces, in a number n, formed by or supported by cantilevered spring members that are simultaneously moved by one or plural coils mounted on said base block, for connecting the first fixed contact terminal, the second fixed contact terminal and the two neighboring fixed conductor pieces simultaneously in a crosslinked manner,

wherein the first fixed contact terminal and the second fixed contact terminal are connected together through serially arranged contact sets of a number of 2n formed by the first fixed contact terminal, second fixed contact terminal, fixed conductor pieces of the number of n−1 and moving conductor pieces of the number of n,

while n is an integer of not smaller than 1.

The thus constituted electromagnetic relay realizes the making and breaking of a voltage on a base block through plural serial contact sets.

The present invention may be more fully understood from the description of preferred embodiments of the invention set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a first embodiment.

FIG. **2** is a side view of the first embodiment.

FIG. **3** is a disassembled view of the first embodiment.

FIG. **4** is a disassembled view of the first embodiment.

FIG. **5** is a diagram illustrating the operation of contact points of the first embodiment.

FIG. **6** is a circuit diagram of the first embodiment.

FIG. **7** is a perspective view of a second embodiment.

FIG. **8** is a side view of the second embodiment.

FIG. **9** is a perspective view of a part of the second embodiment.

FIG. **10** is a perspective view of a part of the second embodiment.

FIG. **11** is a perspective view of a part of the second embodiment.

FIG. **12** is a diagram illustrating the operation of contact points of the second embodiment.

FIG. **13** is a circuit diagram of the second embodiment.

FIG. **14** is a side view of a third embodiment.

FIG. **15** is a side view of a fourth embodiment.

FIG. **16** is a view illustrating the operation of contact points of a fifth embodiment.

FIG. **17***a* & **17***b* are view illustrating how to mount the contact elements, wherein FIG. **17***a* illustrates a case of the present invention, and FIG. **17***b* illustrates a case according to a prior art;

FIG. **18** is a circuit diagram illustrating a prior art.

FIG. **19** is a circuit diagram illustrating a prior art.

Embodiments of the invention will now be described with reference to the accompanying drawings.

FIG. **1** is a perspective view illustrating a state where a cover is removed from an electromagnetic relay of a first embodiment, FIG. **2** is a side view thereof, and FIGS. **3** and **4** are disassembled views thereof.

Referring to the drawings, a first side wall portion **21** and a second side wall portion **22** of a bobbin **20** are secured to a plastic base block **10**, as will be described later, and a vertical portion **31** of an L-type yoke **30** is secured to the first side wall portion **21** of the bobbin **20**. A horizontal portion **41** of a spring member **40** is attached by, e.g., rivets, to a horizontal portion **32** of the yoke **30**, and a hanging portion **43** continues to the horizontal portion **41** of the spring member **40** via a folded portion **42**, the hanging portion **43** extending downward to form a moving conductor piece. An armature **47** made of a magnetic material is attached by caulking to an upper portion **44** of the hanging portion **43**.

The lower portion, in a position where the armature **47** is attached to the hanging portion **43** of the spring member **40**, is branched into two to form a first arm **45** and a second arm **46**. Though the branched shape is not an absolute requirement, it is possible to set suitable spring constants relying on the branched shape and to accomplish the action with a weak magnetic force and, hence, to decrease the amount of electric power consumed by the coil.

Contact elements **45***a*, **46***a* made of a material having an excellent arc-resistance property are attached to the first arm **45** and to the second arm **46**. The back surfaces of the protruded portions of the contact elements **45***a* and **46***a* are scraped out to reduce the material cost.

A first fixed contact terminal **51** and a second fixed contact terminal **52** are mounted on the base block **10**, and have contact elements **51***a* and **52***a* attached thereto. The first fixed contact terminal **51** and the second fixed contact terminal **52** are integrally connected to a first lead terminal **61** and to a second lead terminal **62** which are extending

from the lower side of the base block **10** in the drawing and to which the external conductors (not shown) are coupled, in a manner which will be described later.

The bobbin **20** has an iron core **23** arranged on the inside of a cylindrical portion that is not shown, has a coiled conductor **24** wound on the outer side thereof, and forms a coil C together therewith. An end of the coiled conductor **24** is coupled to an upper portion of a conductor pin **25** mounted on a first side wall **21** of the bobbin **20**, and a lower end of the conductor pin **25** is contacted to a first coil terminal **55** mounted on the base block **10**, the first coil terminal **55** being integrally formed with a third lead terminal **63** which is extending from the lower side of the base block **10** as shown and to which the external conductor (not shown) is coupled, in a manner which will be described later.

Similarly, the other end of the coiled conductor **24** is coupled to an upper portion of a conductor pin **26** (see FIG. **3**) mounted on a second side wall **22** of the bobbin **20**, a lower end of the conductor pin **26** is contacted to a second coil terminal **56** mounted on the base block **10**, the second coil terminal **56** being integrally formed with a fourth lead terminal **64** which is extending from the lower side of the base block **10** as shown and to which the external conductor (not shown) is coupled, in a manner as will be described later.

Further, a third coil terminal **57** having a slot **57***a* is formed integrally with the third lead terminal **63** and, similarly, a fourth coil terminal **58** having a slot **58***a* is formed integrally with the fourth lead terminal **64**. Both ends of a protector element **59** are attached into the slots **57***a,* **58***a* so that an excess current will not flow through the coil C.

When a current is supplied to the third lead terminal **63** and the fourth lead terminal **64** and the coil C is excited, the armature **47** is attracted to the side of the coil C, and the first arm **45** and the second arm **46** of the spring member **40** move to the side of the coil C, too.

As the coil C is excited and the spring member **40** moves toward the coil C, the contact elements **45***a* and **46***a* of the first arm **45** and of the second arm **46** come into contact with the contact elements **51***a,* **52***a* of the first fixed contact terminal **51** and of the second fixed contact terminal **52**.

Therefore, when a voltage is applied to, for example, the first lead terminal **61**, an electric current flows through the first lead terminal **61**, the first fixed contact terminal **51**, the contact element **51***a,* the contact element **45***a,* the first arm **45**, the upper portion **44** of hanging portion **43** of spring member **40**, the second arm **46**, the contact element **46***a,* the contact element **52***a,* the second fixed contact terminal **52** and the second lead terminal **62**. The first pair of contact elements **45***a* and **51***a* form a first contact set CS**1** and the second pair of contact elements **46***a* and **52***a* form a second contact set CS**2**, each of which sets can be spaced apart from each other, as shown by solid lines in FIG. **5**, or can be engaged, completing electrical connections therebetween as shown by phantom lines in FIG. **5**. Thus, the electric current flows through two contact sets CS**1** and CS**2**, and the time for which the arc continues becomes shorter than that of when a single contact set is employed. When the contact gap is the same as that of the single contact set, therefore, the contact portion exhibits improved durability. When the contact gap is narrowed, the electromagnetic relay consumes less electric power.

FIG. **5** is a top view schematically illustrating the flow of electricity, and FIG. **6** is a circuit diagram. In FIG. **6**, symbol Z denotes a load such as motor.

A back-stop plate **11** is molded with a resin integrally with the base block **10**. When the coil C has not been excited, the first arm **45** and the second arm **46** of the spring member **40** come into contact with the back-stop plate **11** and their positions are determined.

The back-stop plate **11** made of a resin is softened or is melted when the current is not completely broken and heat is generated due to arcing in a state where the first arm **45** and the second arm **46** are brought into contact with the back-stop plate **11** without exciting the coil C. Then, the first arm **45** and the second arm **46** move away from the first and second fixed contact terminals **51**, **52** due to their own resilient force. Accordingly, the arc ceases and the area of burning does not spread much. When the back-stop plate **11** is formed of a metal, on the other hand, the arc continues to take place because the back-stop plate **11** does not melt, and the area of burning spreads.

A production method according to the first embodiment will be further described with reference to FIGS. **3** and **4**.

The conductor pins **25** and **26** for passing an electric current to the coil C are insert-molded in the first side wall **21** and in the second side wall **22** of the bobbin **20**.

The bobbin **20** is secured to the base block **10** with its first foot portion **21***a* formed integrally with the first side wall **21** and second foot portion (not shown) formed integrally with the second side wall **22** being inserted in holes **10**A, **10**B of the base block **10**, and with its pawl **21***b* formed at the lower end of the first foot portion **21***a* being engaged with the lower surface of the base block **10**.

As described earlier, the first fixed contact terminal **51** is molded integrally with the first lead terminal **61** to thereby form a first fixed contact terminal assembly **71** as shown in FIG. **4**. The first fixed contact terminal assembly **71** is secured to the base block **10** with its first fixed contact terminal **51** being so insert-molded as to be located in the hole **10***b* of the base block **10**.

As described earlier, the second fixed contact terminal **52** is formed integrally with the second lead terminal **62** to thereby form a second fixed contact terminal assembly **72** as shown in FIG. **4**. The second fixed contact terminal assembly **72** is secured to the base block **10** with its second fixed contact terminal **52** being so insert-molded as to be located in the hole **10***b* of the base block **10**.

As described earlier, the first coil terminal **55** is formed integrally with the third lead terminal **63** and the third coil terminal **57** to thereby form a first coil terminal assembly **73** as shown in FIG. **4**. The first coil terminal assembly **73** is secured to the base block **10** with its first coil terminal **55** and third coil terminal **57** being insert-molded so as to be positioned in the holes **10***d,* **10***e* of the base block **10**.

As described earlier, the second coil terminal **56** is formed integrally with the fourth lead terminal **64** and the fourth coil terminal **58** to thereby form a second coil terminal assembly **74** as shown in FIG. **4**. The second coil terminal assembly **74** is secured to the base block **10** with its second coil terminal **56** and fourth coil terminal **58** being insert-molded so as to be positioned in the holes **10***f,* **10***g* of the base block **10**.

The base block **10** shown in FIG. **4** has not been molded in a shape as described above. From the standpoint of explanation, the base block **10** shown in FIG. **4** shows the mounting positions in a finished state without, however, mounting the terminals.

According to the first embodiment constituted as described above, the electromagnetic relay having two serial contact sets is realized without executing the wiring operation, to suppress the cost, and in a small size.

Next, a second embodiment will be described. FIG. **7** is a perspective view of the second embodiment, and FIG. **8** is a side view thereof.

In the second embodiment, a third fixed contact terminal **53** and a fourth fixed contact terminal **54** are disposed facing the first fixed contact terminal **51** and the second fixed contact terminal **52** with the first arm **45** and the second arm **46** sandwiched therebetween. Contact elements **53***a* and **54***a* are attached to the third fixed contact terminal **53** and to the fourth fixed contact terminal **54**. Further, contact elements **45***b* and **46***b* are attached to the first arm **45** and to the second arm **46** on the back side of the contact elements **45***a* and **46***a*.

Referring to FIG. **9**, the third fixed contact terminal **53** is molded integrally with a fifth lead terminal **65** to form a third fixed terminal assembly **75**. Referring to FIG. **10**, the fourth fixed contact terminal **54** is formed integrally with the second fixed contact terminal **52** and the second lead terminal **62** to form a second fixed contact assembly **72'**.

Holes **10***h* and **10***i* are formed in the base block **10**. The third fixed contact terminal assembly **75** is so insert-molded that the third fixed contact terminal **53** is positioned in the hole **10***h*, and the second fixed contact assembly **72'** is so insert-molded that the second fixed contact terminal **52** is positioned in the hole **10***c* and the fourth fixed contact terminal **54** is positioned in the hole **10***i*.

The third fixed contact terminal **53** works as a break contact terminal, and the fourth fixed contact terminal **54** works as a common contact terminal. The first fixed contact terminal **51** and the second fixed contact terminal **52** are a make contact terminal and a common contact terminal, respectively, as in the first embodiment.

FIGS. **12** and **13** are a schematic view and a circuit diagram illustrating the operation like FIGS. **5** and **6** of the first embodiment. The electric current supplied to the load flows in the same manner as in the first embodiment.

As will be obvious from FIG. **8**, the height of the contact elements **53***a*, **54***a* of the third fixed contact terminal **53** and of the fourth fixed contact terminal **54** from the base block is larger than the height of the contact elements **51***a*, **52***a* of the first fixed contact terminal **51** and of the second fixed contact terminal **52** from the base block. This is because the contact elements **45***a*, **46***a* of the first arm **45** and of the second arm **46** come into contact with the contact elements **51***a*, **52***a* of the first fixed contact terminal **51** and of the second fixed contact terminal **52** when the first arm **45** and the second arm **46** are directed downward nearly vertically, whereas the contact elements **45***b*, **46***b* of the first arm **45** and of the second arm **46** come into contact with the contact elements **53***a*, **54***a* of the third fixed contact terminal **53** and of the fourth fixed contact terminal **54** when the first arm **45** and the second arm **46** are tilted. Then, a stable contact is obtained between the contact elements, and the circuit can be reliably made and broken even for high voltages.

Next, described below is a third embodiment. FIG. **14** is a side view illustrating an electromagnetic relay of the third embodiment. In the third embodiment, in comparison with the first embodiment, an electrically insulating member **80** is interposed between the horizontal portion **32** of the yoke **30** and the horizontal portion **41** of the spring member **40**, and between the hanging portion **43** of the spring member **40** and the armature **47**. Therefore, the electric current is prevented from flowing into the yoke **30** and the armature **47**; i.e., the current carrying portion decreases and less heat is generated. The armature **47** is attached to the hanging portion **43** of the spring member **40** by an electrically insulating fastening fitting.

Next, described below is a fourth embodiment. FIG. **15** is a side view illustrating an electromagnetic relay of the fourth embodiment. In the fourth embodiment, in comparison with, the first embodiment, the hanging portion **43** of the spring member **40** is terminated nearly at the end of the armature **47**, the electrically insulating member **80** is overlapped on the hanging portion **43**, and a sub-hanging portion **43'** is overlapped on the electrically insulating member **80**. Then, the hanging portion **43**, the electrically insulating member **80** and the sub-hanging potion **43'** are all secured to the armature **47** by using an electrically insulating fastening fitting, and the lower side of the sub-hanging portion **43'** is branched into two to form the first arm **45** and the second arm **46**. Therefore, the current carrying portion is further decreased to generate even less heat.

The third and fourth embodiments can be applied even to the second embodiment.

Next, described below is a fifth embodiment, as shown in FIG. **16**. In the fifth embodiment, a fixed conductor piece **150** is disposed between the first fixed contact terminal **51** and the second fixed contact terminal **52** of the first embodiment, and contact elements **150***a* and **150***b* are attached to near both ends of the fixed conductor piece **150**. Further, a first separate moving piece **140** and a second separate moving piece **240** separated from each other through the insulating member **80** are attached to the hanging portion **43** of the spring member **40**. The first separate moving piece **140** and the second separate moving piece **240** are branched into two, respectively. The first separate moving piece **140** has, attached thereto, a contact element **140***a* that comes in contact with the contact element **51***a* of the first fixed contact terminal **51** and a contact element **140***b* that comes in contact with the contact element **150***a* of the fixed conductor piece **150**, and the second separate moving piece **240** has, attached thereto, a contact element **240***a* that comes in contact with the contact element **52***a* of the second fixed contact terminal **52** and a contact element **240***b* that comes in contact with the contact element **150***b* of the fixed conductor piece **150**.

When the coil C is excited, therefore, an electric current flows through the first lead terminal **61**; the first fixed contact terminal **51**, the contact element **51***a*, the contact element **140***a*, the first separate moving piece **140**, the contact element **140***b*, the contact element **150***a*, the fixed conductor piece **150**, the contact element **150***b*, the contact element **240***b*, the second separate moving piece **240**, the contact element **240***a*, the contact element **52***a*, the second fixed contact terminal **52** and the second lead terminal **62**. Thus, the electric current flows through four contact sets, the time in which the arc continues is further shortened, and the resistance against the arc is further improved.

The fifth embodiment has dealt with the case where only one fixed conductor piece was used. Similarly, however, it is also allowable to increase the number of the fixed conductor pieces.

The effect of the serial arrangement is lost if the contact sets are closed and opened in a dispersed manner. It is therefore desired that the contact sets are so controlled as to be closed or opened all within a predetermined period of time, e.g., within 0.1 ms. Concretely speaking, this is done by controlling the spring constant of the spring member that is a material forming the moving conductor pieces.

This holds true even when there is no fixed conductor piece as in the first through fourth embodiments or even when there are many fixed conductor pieces.

Next, described below is the attachment of the contact element to the first fixed contact terminal **51** in each of the

embodiments. FIG. **17***a* is a diagram illustrating a portion of the first fixed contact terminal **51** of a decreased thickness and to which the contact element **51***a* is affixed, as a rivet. FIG. **17***b* illustrates a conventional attachment. As will be obvious from the comparison of the two, an intermediate portion M of the contact element **51***a* in the embodiment of the invention is smaller than an intermediate portion M' that is attached according to the prior art, and reduces the material cost.

What is claimed is:

1. An electromagnetic relay comprising:

a first fixed contact terminal and a second fixed contact terminal spaced from each other on a first main surface of a base block;

fixed conductor pieces of a number n−1 mounted in adjacent, spaced relationship on said one surface of said base block in alignment with, and between, the first fixed contact terminal and the second fixed contact terminal; and

an L-type yoke affixed to the base and having a first leg transverse to the first main surface of the base in a second leg extending parallel to and spaced from the first main surface and a coil mounted therebetween having a axis parallel to the first main surface;

an armature and a generally L-shaped spring having a first leg portion, a central mounting portion secured to a central portion of an outer surface of the armature and resiliently displacing the armature from the coil and a second leg portion comprising at least one moving conductor piece, in a number n, supported by the cantilevered spring member portion and simultaneously moved with the armature by energization of the coil mounted on said base block, for connecting the first fixed contact terminal, the second fixed contact terminal and the two adjacent fixed conductor pieces simultaneously in a series circuit relationship, a central, extension portion of the spring, integral with the central portion thereof, extending to and engaging an upper portion of the outer surface of the armature; wherein:

the first fixed contact terminal and the second fixed contact terminal are connected together through serially arranged contact sets of a number 2n formed by the first fixed contact terminal, the second fixed contact terminal, the fixed conductor pieces of the number n−1 and the moving conductor pieces of the number n, and

n is an integer not smaller than 2.

2. An electromagnetic relay according to claim **1**, wherein a third fixed contact terminal is provided facing the first fixed contact terminal with the moving conductor pieces sandwiched therebetween, and a fourth fixed contact terminal is provided facing the second fixed contact terminal with the moving conductor pieces sandwiched therebetween, the first fixed contact terminal serving as a make terminal, the third fixed contact terminal serving as a break terminal, and the second fixed contact terminal and the fourth fixed contact terminal conductive to each other serving as a common terminal.

3. An electromagnetic relay according to claim **1**, wherein the number of the coils is one.

4. An electromagnetic relay according to claim **1**, wherein the moving conductor pieces have a branched shape on the side on where they come in contact with the first fixed contact terminal, the second fixed contact terminal and the adjacent and spaced fixed conductor pieces.

5. An electromagnetic relay according to claim **1**, wherein the moving conductor pieces are supported by the spring member via an electrically insulating member.

6. An electromagnetic relay according to claim **1**, further comprising a stopper which the moving conductor pieces contact, defining their positions when the coil is not excited, the stopper being molded with a resin integrally with the base block.

7. An electromagnetic relay according to claim **1**, wherein contact elements are attached to the portions of the first and second fixed contact terminals, of the third and fourth fixed contact terminals, of the fixed conductor pieces and of the moving conductor pieces that come in contact with one another, the contact elements protruding toward the contacting side, and the regions of the members to where the contact elements are attached have a decreased thickness on the side on where the contact elements are caulked.

8. An electromagnetic relay according to claim **1**, wherein the coil is one obtained by arranging an iron core on the inside of a cylindrical portion of a bobbin that has a plate portion and the cylindrical portion and by arranging a coiled conductor on the outer side of the cylindrical portion, the bobbin is secured to the base block with its plate portion being inserted in a hole formed in the base block and with its hook formed on the plate member being engaged with the base block, and the coiled conductor is connected to a terminal of the coil mounted on the base plate via a conductor member for the coil, the conductor member for the coil being insert-molded in the bobbin.

9. An electromagnetic relay according to claim **8**, wherein the first and second fixed contact terminals or the third and fourth fixed contact terminals and coil terminals are formed by machining an electrically conducting plate memeber integrally with the lead terminals which protrude from the other surface of the base block and to which the external conductors are connected, and are, then, insert-molded in the base block.

10. An electromagnetic relay according to claim **9**, wherein there are provided a pair of terminals each having a slot, and a protection element is mounted with its both ends being inserted in the pair of slots.

11. An electromagnetic relay according to claim **2**, wherein:

contact elements are attached to the portions of the first and second fixed contact terminals, of the third and fourth fixed contact terminals, of the fixed conductor pieces and of the moving conductor pieces so as to protrude toward the side of the contact surface;

the angle of the moving conductor pieces, relative to the vertical line, when they come into contact with the first and second fixed contact terminals, is different from the angle of the moving contact pieces, relative to the vertical line, when they come into contact with the third and fourth fixed contact terminals;

the contact elements of the moving conductor pieces that come into contact with the contact elements of the first and second fixed contact terminals and the contact elements of the moving conductor pieces that come in contact with the contact elements of the third and fourth fixed contact terminals, are located at an equal distance from the center of movement of the moving pieces; and

a height of the contact elements of the third and fourth fixed contact terminals from the base block is different from a height of the contact elements of the first and second fixed contact terminals from the base block, so that the contact elements of the moving conductor pieces come in contact with the contact element of the first fixed contact terminal and with the contact element of the third fixed contact terminal at their centers and come in contact with the contact element of the second

fixed contact terminal and with the contact element of the fourth fixed contact terminal at their centers.

12. An electromagnetic relay according to claim **1**, wherein plural contact sets are closed and opened within a predetermined period of time.

13. An electromagnetic relay according to claim **2**, wherein plural contract sets are closed and opened within a predetermined period of time.

14. An electromagnetic relay according to claim **2**, wherein contact elements are attached by caulking to the portions of the first and second fixed contact terminals, of the third and fourth fixed contact terminals, of the fixed conductor pieces and of the moving conductor pieces that come in contact with one another, the contact elements protruding toward the contacting side, and the regions of the members to which the contact elements are caulked have a decreased thickness on the side on which the contact elements are caulked.

15. An electromagnetic relay according to claim **2**, wherein the coil is one obtained by arranging an iron core on the inside of a cylindrical portion of a bobbin that has a plate portion and the cylindrical portion and by arranging a coiled conductor on the outer side of the cylindrical portion, the bobbin is secured to the base block with its plate portion being inserted in a hole formed in the base block and with its hook formed on the plate member being engaged with the base block, and the coiled conductor is connected to a terminal of the coil mounted on the base plate via a conductor member for a coil, the conductor member for coil being insert-molded in the bobbin.

16. An electromagnetic relay according to claim **1**, wherein the outer surface of the armature has a stepped configuration at the juncture of the central portion and the lower portion whereby the lower portion of the spring member is displaced from the lower portion of the outer surface of the armature.

17. An electromagnetic relay according to claim **1**, wherein the first leg portion, the central portion, the extension therefrom and the second leg portion of the spring comprises a single unitary structure.

18. An electromagnetic relay according to claim **2**, wherein the spring member comprises a first element including the first leg portion and an integral and unitary end extension and a second element comprising an end extension overlapping the end extension of the first member and together comprising the central portion secured to the armature and a second leg portion comprising the moving conductor piece.

19. An electromagnetic relay according to claim **18**, further comprising an insulating layer separating the respective end portions of the first and second spring members.

20. An electromagnetic relay comprising:

a first fixed contact terminal and a second fixed contact terminal spaced from each other on a first main surface of a base block;

fixed conductor pieces of a number n mounted in adjacent, spaced relationship on said one surface of said base block in alignment with, and between, the first fixed contact terminal and the second fixed contact terminal; and

an L-type yoke affixed to the base and having a first leg affixed to, and extending transverse to, the first main surface of the base and a second leg extending parallel to and spaced from the first main surface and having a free end and a coil mounted therebetween having a axis parallel to the first main surface and extending to the free end of the second leg of the yoke;

an armature and a generally L-shaped spring providing a cantilevered, resiliently biased support of the armature from the free end of the second leg of the yoke, normally displaced from the coil and movable by energization of the coil for rotation about the free end of the second leg of the yoke and toward the coil, against the resilient bias of the spring, for connecting the first fixed contact terminal, the second fixed contact terminal and the two adjacent fixed conductor pieces simultaneously in a series circuit relationship, the spring having a first leg portion secured to the first leg of the yoke, a pair of spaced, folded portions extending from the first leg portion and over the free end of the yoke and an upper portion of the armature, connecting at respective fold lines to corresponding, laterally spaced portions of a central portion of the spring, the central portion contacting and being secured to the central portion of the armature and including a stabilizing extension portion between the fold lines and disposed on the upper portion of the armature and a lower portion extending from the central portion and carrying thereon the moving conductor pieces in a number n:

the first fixed contact terminal and the second fixed contact terminal are connected together through serially arranged contact sets of a number 2n formed by the first fixed contact terminal, the second fixed contact terminal, the fixed conductor pieces of the number n−1 and the moving conductor pieces of the number n, and

n is an integer not smaller than 2.

21. An electromagnetic relay according to claim **20**, wherein a third fixed contact terminal is provided facing the first fixed contact terminal with the moving conductor pieces sandwiched therebetween, and a fourth fixed contact terminal is provided facing the second fixed contact terminal with the moving conductor pieces sandwiched therebetween, the first fixed contact terminal serving as a make terminal, the third fixed contact terminal serving as a break terminal, and the second fixed contact terminal and the fourth fixed contact terminal conductive to each other serving as a common terminal.

22. An electromagnetic relay according to claim **20**, wherein the moving conductor pieces have a branched shape on the side on where they come in contact with the first fixed contact terminal, the second fixed contact terminal and the adjacent and spaced fixed conductor pieces.

23. An electromagnetic relay according to claim **20**, wherein the moving conductor pieces are supported by the spring member via an electrically insulating member.

24. An electromagnetic relay according to claim **20**, further comprising a stopper which the moving conductor pieces contact, defining their positions when the coil is not excited, the stopper being molded with a resin integrally with the base block.

25. An electromagnetic relay according to claim **20**, wherein contact elements are attached to the portions of the first and second fixed contact terminals, of the third and fourth fixed contact terminals, of the fixed conductor pieces and of the moving conductor pieces that come in contact with one another, the contact elements protruding toward the contacting side, and the regions of the members to where the contact elements are attached have a decreased thickness on the side on where the contact elements are caulked.

26. An electromagnetic relay according to claim **20**, wherein the coil is one obtained by arranging an iron core on the inside of a cylindrical portion of a bobbin that has a plate

portion and the cylindrical portion and by arranging a coiled conductor on the outer side of the cylindrical portion, the bobbin is secured to the base block with its plate portion being inserted in a hole formed in the base block and with its hook formed on the plate member being engaged with the base block, and the coiled conductor is connected to a terminal of the coil mounted on the base plate via a conductor member for the coil, the conductor member for the coil being insert-molded in the bobbin.

27. An electromagnetic relay according to claim **26**, wherein the first and second fixed contact terminals or the third and fourth fixed contact terminals and coil terminals are formed by machining an electrically conducting plate member integrally with the lead terminals which protrude from the other surface of the base block and to which the external conductors are connected, and are, then, insert-molded in the base block.

28. An electromagnetic relay according to claim **27**, wherein there are provided a pair of terminals each having a slot, and a protection element is mounted with its both ends being inserted in the pair of slots.

29. An electromagnetic relay according to claim **20**, wherein plural contact sets are closed and opened within a predetermined period of time.

30. An electromagnetic relay according to claim **20**, wherein plural contact sets are closed and opened within a predetermined period of time.

31. An electromagnetic relay according to claim **20**, wherein the outer surface of the armature has a stepped configuration at the juncture of the central portion and the lower portion whereby the lower portion of the spring member is displaced from the lower portion of the outer surface of the armature.

32. An electromagnetic relay according to claim **21**, wherein the spring member comprises a first element including the first leg portion and an integral and unitary end extension and a second element comprising an end extension overlapping the end extension of the first member and together comprising the central portion secured to the armature and a second leg portion comprising the moving conductor piece.

33. An electromagnetic relay according to claim **32**, further comprising an insulating layer separating the respective end portions of the first and second spring members.

34. An electromagnetic relay according to claim **1**, wherein the lower portion of the spring comprises a pair of spaced, parallel arms carrying respective, moving contact elements.

35. An electromagnetic relay, comprising:

an insulating base having a main surface;

first and second fixed contacts, supported on the main surface of the insulating base, spaced apart from each other along an axis and having contact elements disposed substantially transversely to the insulating base main surfaces; and

a cantilevered spring member of first and second arm portions integrally connected by a pair of laterally spaced folded portions in an L-shaped configuration, the first arm being supported by the insulating base so as to extend parallel thereto;

a coil disposed between the first spring member and the main surface and having an active end;

the second arm portion being connected to a surface of, and carrying thereon, an armature, the second arm portion having an integral extension, disposed intermediate the pair of laterally spaced folded portions, extending to, and disposed on, an upper portion of the armature surface relatively to the connection of the second arm to the armature surface, the second arm being rotated relatively to the first arm about a second axis parallel to the first axis against the resilient biasing thereof upon energization of the coil; and

the second arm carrying first and second movable contacts adjacent a free end thereof which move by the rotation of the second arm, from positions displaced from, to positions electrically contacting, the first and second fixed contacts, the second arm of the cantilevered spring member electrically, serially connecting the first and second fixed contacts when engaged by the respective, first and second movable contacts.

36. The electromagnetic relay as recited in claim **35**, wherein:

the plural fixed contacts comprise first and second, electrically non-connected contact terminals having respective contact surfaces; and

the plural movable contact surfaces comprise first and second electrically connected movable contact surfaces which contact the respective fixed contact surfaces respectively of the first and second electrically non-connected contact terminals and the movable contacts electrically serially interconnect same.

37. The electromagnetic relay as recited in claim **35**, wherein:

the plural fixed contacts further comprise third and fourth serially electrically connected contact surfaces aligned with and disposed between the respective contact terminals of the first and second electrically non-connected contact terminals; and

the plural movable contact surfaces comprise first and second pairs of electrically interconnected movable contact surfaces, the first pair electrically contacting and serially interconnecting the first and third fixed contacts and the second pair electrically contacting and serially interconnecting the second and fourth fixed contact surfaces.

38. The electromagnetic relay as recited in claim **35**, wherein:

each movable contact and respective fixed contact element electrically contacted thereby, together, define a contact set.

39. The electromagnetic relay as recited in claim **35**, wherein:

the plural fixed contacts further comprise a fixed contact element having a pair of fixed contact surfaces aligned on the third axis and spaced between the respective fixed contact surfaces of the first and second fixed contacts; and

the movable contact further comprises a further pair of electrically connected contact surfaces spaced along the second axis; and

the first pair of movable contact surfaces electrically contact the respective fixed contact surfaces of the first fixed contact and the adjacent fixed contact of the fixed contact element and the movable contact electrically connecting same in series and the second pair of movable contact surfaces electrically contacting the respective fixed contact surfaces of the second fixed contact and the adjacent fixed contact surface of the fixed contact element and the movable contact electrically connecting same in series.

40. An electromagnetic relay, comprising:

an insulating base;

first and second fixed contacts having respective fixed contact surfaces and (n−1) fixed conductor elements separating the first and second fixed contacts and each having a pair of respective fixed contact surfaces, the first and second fixed contacts being supported on a main surface of an insulating base and spaced from each other along a first axis;

a cantilevered spring member of an L-shaped configuration in a rest condition and defining first and second arm portions, the first arm portion being supported by the base and the second arm portion being rotatable relatively to the first arm portion about a second axis, parallel to the first axis, and carrying (n) moveable contacts thereon adjacent a free end thereof and aligned along a third axis, parallel to the first and second axes, the first and third axes being spaced by a common distance from the second axis;

each movable contact comprising a pair of electrically connected, movable contact surfaces;

a coil mounted on the insulating base and, when electrically energized, rotating the second arm portion relatively to, and toward, the first arm portion, against a resilient force of the cantilevered spring member, and thereby moving the (n) movable contacts from positions displaced from, to positions electrically contacting, respective fixed contact surfaces, each pair of adjacent movable contacts electrically contacting and serially connecting a respective pair of fixed contact surfaces; and

n is a positive integer not smaller than two.

41. The electromagnetic relay as recited in claim **40**, wherein the fixed contact surfaces are disposed substantially transversely to the insulating base.

42. The electromagnetic relay as recited in claim **40**, wherein:

the first and second fixed contacts respectively comprise first and second, electrically non-connected contact elements.

43. The electromagnetic relay as recited in claim **40**, wherein:

each of the first and second movable contacts comprises a respective pair of movable contact elements;

the respective pair of movable contact elements of the first movable contact electrically contact the respective, and adjacent, fixed contact elements of the first fixed contact and the adjacent fixed contact element of the fixed conductor element and the same are serially connected by the first movable contact; and

the respective pair of movable contact elements of the second movable contact electrically contact the respective, and adjacent, fixed contact elements of the second fixed contact and the adjacent fixed contact element of the fixed conductor element and the same are serially connected by the second movable contact.

44. The electromagnetic relay as recited in claim **43**, wherein:

the plural fixed contacts further comprise third and fourth serially electrically connected contact elements; and

the plural movable contacts comprise first and second adjacent pairs of movable, electrically connected contacts, respectively serially connecting the first and the third fixed contacts and the fourth and the second fixed contacts when electrically contacting same.

45. The electromagnetic relay as recited in claim **40**, wherein:

each movable contact and a respective fixed contact element, electrically contacted thereby, together define a contact set.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 6,677,840 B2
DATED : January 13, 2004
INVENTOR(S) : Akihiko Nakamura et al.

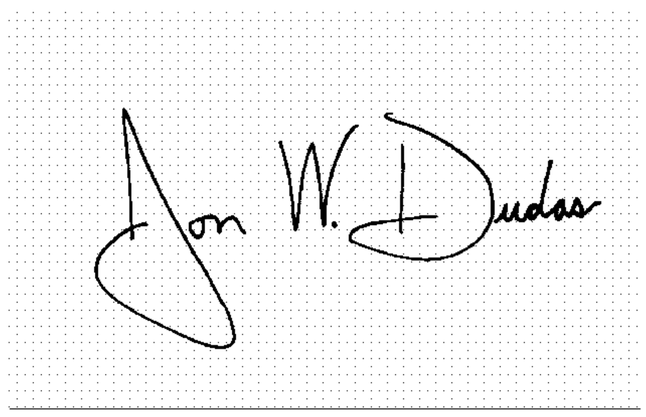
It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title page,
Item [56], **References Cited**, FOREIGN PATENT DOCUMENTS, insert

-- 0 382 525 A1	08/1990	European Patent Office
SU 686091 A	09/1979	USSR
2 257 832 A	01/1993	Great Britain
2 335 029	07/1977	France --

Signed and Sealed this

Eleventh Day of January, 2005



JON W. DUDAS
Director of the United States Patent and Trademark Office